SUPPLEMENT.

The Mining Journal,
RAILWAY AND COMMERCIAL GAZETTE:
FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

No. 1787.—VOL. XXXIX. LONDON, SATURDAY, NOVEMBER 20, 1869. {STAMPED .. SIXPENCE. UNSTAMPED. FIVEPENCE.

PREVENTION OF COLLIERY EXPLOSIONS—GUNPOWDER AND BLASTING SUPERSEDED.

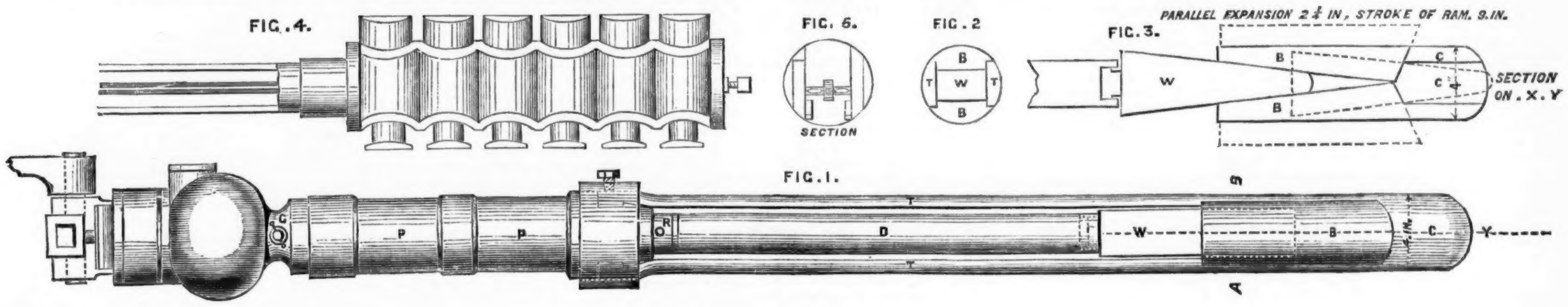
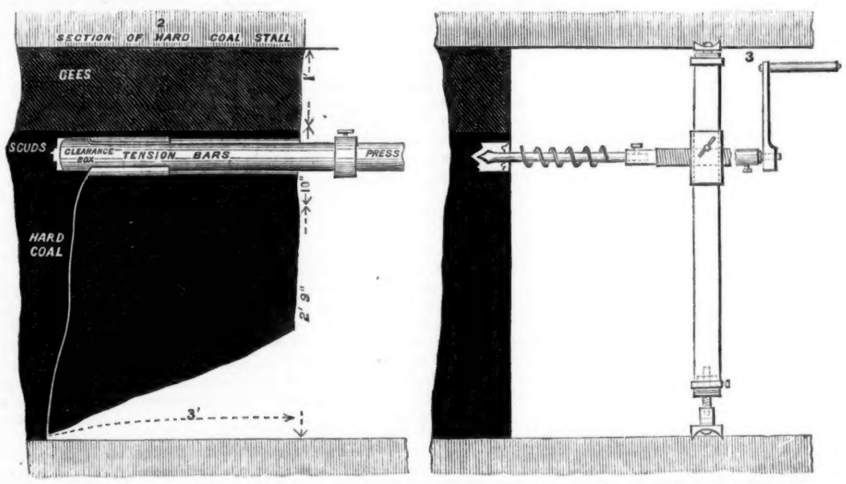


Fig. 2 is a section on the line A B in Fig. 1.



The feeling that blasting with gunpowder in collieries should be prohibited by legislative enactment continually gains ground with the public, and the success which has attended the practical trials with the wedging machines at the Harecastle and Shipley Collieries is gradually convincing even men accustomed to colliery working that the idea of substituting mechanical for explosive action in the breaking down of coal is not so completely Utopian as was at first supposed. A most interesting paper, "On the Use of Hydraulic Machines for Breaking Down Coal," was read at a recent meeting of the Midland Institute of Mining Engineers, by Mr. Lupton, and we are now enabled to give diagrams of Mr. James Grafton Jones's machine, a modification of which, by Mr. S. P. Bidder, jun., was fully described in the *Mining Journal*, of July 10. To facilitate description of these machines, and enable their contemplated sphere of action to be more readily understood, Mr. Lupton briefly mentions the principal methods in which coal is got from the solid. According to the first method, the face of the coal is undercut, and the coal either falls by its own weight, or is forced down by the weight of the superincumbent strata. The second method is when the holing is made above the coal, or when the coal is undercut, and will not fall without the application of power. In this case the coal is often blown down by the use of gunpowder, and in other cases where the use of powder injures the coal, or is dangerous by reason of the probable presence of fire-damp, the coal is brought down, or forced up, as the case may be, by means of wedges, driven in by hand hammers. The third method is practised in South Wales, North Staffordshire, and other places where the coal is divided by numerous slines or slips into irregularly shaped masses. At these slines the coal can be so easily separated from the solid, that holing is sometimes altogether unnecessary, and here the coal can be got by judiciously placed shots, and by the use of the crowbar and hand-driven wedges. The fourth method is in driving headings where it is common to hole at the end, and to cut one side, and then to break down the coal by means of gunpowder. In the last three cases it is proposed to supplant to some extent the use of powder and hand-hammer driven wedges by the use of hydraulic machinery. There are three patentees of this description of coal-breaking machinery, Mr. James Grafton Jones, Mr. Charles John Chubb, and Mr. Samuel Parker Bidder, jun., who is associated with Mr. John Jones. Mr. Grafton Jones's patent is dated June, 1867; Mr. Chubb's, May, 1868; and Mr. Bidder's, November, 1868.

The principle of the machine illustrated above, and which is one of those referred to in the patent of Mr. J. Grafton Jones, of June, 1867, consists in driving a wedge by means of a hydraulic press between two blocks of steel, which are rendered incapable of any but lateral movement, by means of tension bars connecting them with the press. In Fig. 1, P is the press; R, the ram; T T, the tension bars; B B, pressing block; W, wedge; C, the clearance box, in one piece with the tension bars. The diameter of the clearance box is 4 in., and the length of the tension bars and clearance box 3 ft. 6 in. D is a movable distance piece. The capabilities of the machine were carefully and thoroughly tested by Mr. Lupton, at the Shipley Colliery, in Derbyshire. The Hard coal is there worked on the long wall system, in banks of from 80 yards to 100 yards in length, and the section is—roof bind; Gees, or inferior stone Cannel (used for packs), 1 ft.; Scuds (soft coal, 4 in.; smut parting, 0; soft coal, 6 in.), 10 in.; hard coal, 2 ft. 9 in.=4 ft. 7 in. The subjoined diagrams show section of a stall on the left side of the gate-road, where a length of 20 yards was holed 3 feet under. At a point, 15 yards from the gate end, a hole was drilled in the Scuds, 3 ft. long and 4½ in. in diameter. The tension bars, with the pressing blocks and wedge, and with the press attached, were then inserted into the hole; the sprags having been removed, the pump was worked by one man, the pump handle projecting sufficiently far from the coal to enable him to work with safety. A few minutes pumping forced in the wedge between the pressing blocks sufficiently to make the coals bump and crack ominously, and before the ram had reached the end of its stroke the coal was broken down for a length of 10 yards, the Gees and Scuds above the parting remaining up. Another hole was then drilled in the Scuds at the point B, in the middle of the length of nine yards remaining between this fall and the gate end. The machine was set to work as before, and this time the length of nine yards was forced down, bringing with it the Scuds and Gees. The remaining part of the bank, 18 yards in length, was then holed, and the machine applied as before, in a hole drilled at the point, C, in the Scuds. The whole length was brought down at once, the Gees and Scud above the parting remaining up. These experiments being made with the aid of men who had never handled such machines before, and with a drilling apparatus not suited to the position in which the holes had to be drilled, occupied a long time; but it is Mr. Lupton's opinion that two men, accustomed to the work, and with the improved drilling apparatus since constructed, could have easily performed all the operations required in drilling one hole and fixing the machine in 45 minutes, thus taking from two to three hours, and obtaining three falls. The usual time that it would take two men to wedge down as much coal as was done by the machine in these three experiments is between one and a half and two days.

The Shipley Soft coal is worked on the end, and is holed from 3 ft. to 4 feet under; it requires to be blown down with gunpowder, and this operation makes a good deal of slack, and fills the air with fumes, objectionable both on the score of health and comfort. Five experiments were made in some Soft coal stalls; the holes were bored 3 ft. in, near the roof, and the machines applied as before. The first time, owing to a fault in the coal, a lump of only 1 ton was broken down. The second time, a length of 33 ft. of face, and weighing about from 12 to 15 tons, was brought down; the other times, lumps of coal of from 2 to 4 or 5 tons were brought down. In considering the value of these experiments, it must be remembered that the machines were applied without that judgment that experience alone can give, and which would enable much more surprising results to be obtained. In the same stall where these experiments were tried Mr. Lupton saw two shots fired, each time bringing down a small quantity of coal, not exceeding 1 ton, or 30 cwts.

Having brought the experiments at Shipley to a satisfactory conclusion, the invitation of Mr. P. Cooper was taken advantage of to make further experiments at the Holmes Colliery. The first experiment was similar to those already described: a hole was drilled near the roof of a stall in which the coal was holed for a few yards, and one minute's gentle pumping sufficed to fetch down about 5 yards of face. Experiments were then made to see if the coal could be got without previously holing it; these experiments cannot be said to have as yet resulted in entire success, although enough was done to encourage the writer to continue his experiments in the endeavour to accomplish that most desirable object.

In addition to the wedge-machine, one of another design was used in the foregoing experiments, and proved equally effective. This machine is shown in Figs. 4 and 5. It is constructed from a solid round bar of steel, 4½ in. diameter and 17¼ in. long; six holes, 2⅜ in. diameter, are bored transversely through this bar. These holes serve for cylinders for as many rams on each side; a hole, ¼ in. diameter, bored longitudinally through the bar, connects these cylinders. To a projection at one end of the bar is screwed a tube 2½ in. external diameter and 17 in. long, on to the end of which is fixed a force-pump, made by Tangye. The water from the pump is carried through a copper tube with a very small bore, which is inside the 2½-in. tube above mentioned, and is screwed into the bar carrying the rams; the 2½-in. tube, together with the cast-iron globe to which the pump is fixed, serve as an air-tight reservoir for the water required by the pumps. By working the pump, the rams on either side are gradually forced out from the bar, the rams on one side have a stroke of only ½ in., and are prevented from coming out of the bar by collars strong enough to stand the pressure. The rams on the opposite side have a stroke of 1⅜ inch, and the cylinders of these rams have an escape hole for the water, so as to avoid all danger of forcing the rams out of them. It will be seen that by this system of having rams on both sides of the bar no strain is thrown on it. Before this plan was invented rams were placed on one side of the bar only; the bar had thus to sustain the pressure of the rams, wherever, owing to unevenness of the hole, the bar was not supported by the coal, and as a result it was often strained or broken. The spindle that carries the pump-handle, and the short lever (1½ inch long) that works the pump-plunger, is placed in brackets which can revolve, so that the man who works the pump can have the handle in any position that he chooses. One man can apply a pressure equal to about 10 tons on the square inch by means of this pump. The area of each ram is 4·4 square inches, thus each has a force equal to 44 tons, and all six have a combined force equal to 264 tons.

The area of the ram in the wedge machine is very nearly 6 square inches, and, with a pressure of 10 tons on the inch, it has a force of 60 tons. The stroke is 9 inches, and the expansion (with the present construction of wedge) 2¼ inches, thus the power of the ram is multiplied by 4, giving a total bursting force of 240 tons.

When the rams in either machines have completed their stroke, by turning the cock C, communication is opened between the pressure-pipe and the air-tight reservoir, the vacuum in this then sucks back the rams, enabling the instruments to be easily withdrawn.

Mr. Grafton Jones has also constructed a modification of the machine last described, the advantage of which consists in doing away with the force-pumps, which sometimes get out of order, and in their place is substituted a screw-ram, which advances into the reservoir of water, and so forces out the short rams on the bar. It is intended also to apply this modification to the wedge machine.

In considering the relative merits of the hydraulic machines, it is impossible to say which is the best, because each one may be found to be the best adapted for one mine, and the worst for another. Where a large amount of expansion is requisite, and only a moderate pressure necessary, the wedge machine will, perhaps, be found the most suitable; but where only a small amount of expansion is required (in some cases less than 1 in. is sufficient), and at the same time a very great pressure is necessary, as in the case of breaking down coals that have been undercut, Mr. Lupton thinks the ram machine is the best, because there is *less friction* in moving the rams than in moving the wedge, and the machine being all in one piece is more handy, and less liable to damage. The application of the screw-pump will be a great improvement. It may also be a good plan to make the rams at the end of the instrument of larger diameter than those near the front of the hole, as more power and a shorter stroke is required at the back of the hole. To conclude, in every case where he has seen the machines tried they have effectually done at least as much work as powder would have done under similar circumstances, and owing to the gradual manner in which the powder is applied, more coal is generally got than could have been done with powder; and although it is not claimed that an acre of coal can be worked more cheaply with these machines than with powder, there is no doubt that less slack is made, and that the condition of the mine is more healthy; whilst where the coal is got by the ordinary plan of wedging, it is the opinion of the writer that a great saving of labour may be in many cases effected by the use of these machines.

PROTECTION AGAINST FIRE-DAMP IN MINES.—A number of practical miners assembled at the Tividale, or "Oakham" pits, for the purpose of testing a "perfect safety-lamp," which not only indicates the presence of fire-damp, but rings an alarum bell to inform the men of their danger. Some 40 or 50 persons descended the pit, under the guidance of Mr. Thomas Latham, the general manager, and consulting agent to Earl Dudley, who owns the colliery. At a "sump hole," 4 feet in diameter, and containing at least 50 cubic feet of "fire-damp," it was determined to try the efficacy of the new patent lamp to indicate the gas. Mr. Latham said the lamp was upon the principle of the old Davy, with a difference, inasmuch as it was enclosed in an oaken case (with wire-gauze one-sixth of an inch square), which prevented any-one tampering with it, thereby rendering it considerably safer. Near to the flame was a piece of lead, intimately connected with other machinery. When the lamp was placed in a certain spot, and gas, whether issuing regularly or by a "blower," surrounded it, the flame melted the lead, which allowed a weight to drop, and at once extinguished the lamp, and an alarum bell rung for the protection of the miner. After this brief address it was determined to put the lamp to the most severe test. It was hoisted upon a stick in the hole above mentioned. The fire-damp at once played with a light-blue flame around the lamp. The light in the Davy lamp increased, heated to melting point the lead in the lamp, extinguished itself, and rang the bell. The new invention was then carried away and critically examined. It was seen that there were two brass slides depending on the piece of lead subjected to the flame or heat, and that when the lead melted these slides immediately fell down and excluded the oxygen, thereby at once depriving the flame of all power of combustion. The fall detached a small pin, which set going the hammer upon the bell. This would give the miner time to escape; for the alarum sounded more than a minute and half. Providing they were working with lamps, as in the North of England, with the new lamp close to them, the presence of fire-damp would be made known without any fear of explosion (the light being extinguished by the action of the gas itself), and plenty of time given to the miner to escape. Three separate times was the lamp tried, and each time with the same result. Among the company were Mr. Simeon Bradley and Son, Mr. E. Davies (firm of Messrs. Taylor and Davies), Mr. James Evans, Mr. W. Bulger, Mr. W. Page, Mr. A. Hand, Mr. Passfield, Mr. J. Warr, Mr. A. Smith, Mr. Berthon (of the West Drayton Iron Works), and fifteen or twenty chartermasters from various parts of the neighbourhood. The inventors of the lamp (Messrs. J. and J. Hyde Bros., James-street, West Bromwich) were highly praised for their novel lamp,

although most of the company thought it far more suitable for the North of England, where sulphur was plentiful. The manufacturers of the lamp state that "when the lamp is set for work the strip of lead holds up the rods with valves open, and so long as the pit is free from gas the lamp will continue to burn. But as soon as gas approaches the part of the pit where the lamp is set, the gas ignites in the gauze and melts the lead, causing the rod to drop and close the valves, thus extinguishing the light and simultaneously liberating the alarum."—*Birmingham Daily Post.*

Original Correspondence.

STROLLS IN THE BLACK COUNTRY.

IRON WORKS NEAR DARLASTON.

SIR,—Comparisons are said to be odious. If they are, we can only say that they are very frequently interesting as well. A great deal depends upon the purpose and object of the comparison. Of late the unseemly object—the blast-furnace—has been subject to this process of thought—"odious comparison." Like something of the organic genius, it has been a thing of growth and gradual development. Its commencement in Pensnett common appeared as rude and unseemly as the "monad." Gradually it showed signs of vitality in alteration of shape and extension of size. To-day we may almost say we can study it in its maturity, and it is in the comparison of it now with what it was in its early history that we find so much of interest and so much of instruction. Through the instrumentality of intelligent men and the cheap press we do know a great deal about the past and present history of the iron trade, or the history of "iron smelting." Middlesborough has astonished us in the rapid strides of scientific advancement in this direction, but we must never forget in our comparison of this district with our time-honoured Black Country that the latter lived first, that the latter with hard experience laid the foundations upon which other seemingly more prosperous iron-making districts have built their proportions. We have had before us in these columns many details of the smelting of iron in the district mentioned. We now purpose giving a picture of furnaces at work in the neighbourhood of Darlaston—Rough Hay furnaces, belonging to Messrs. Addenbrooke, Smith, and Pidcock. We fix upon these works because we have reason to believe that they are as complete in all their arrangements as any in the Black Country. At all events, a consideration of their *modus operandi* will give your readers an idea of what is being done in South Staffordshire towards economising fuel and mineral in iron smelting.

The first thing of interest noticeable on entering the domain of the estate in question was the plying of the busy wheels of locomotives. Here, there, and everywhere in the most inconceivable places could be seen these engines doing the work formerly accomplished by a dozen or more quadrupeds. On enquiry we found that the service rendered by one locomotive in drawing coals from a pit over half-a-mile from the works was equal to 4d. per ton on a sufficient quantity of coals required to supply the demands of two furnaces. A moment's thought reveals the immense saving in the superceding of animal power by the power generated from a few coals in a locomotive, &c. These engines deliver the coals direct from the pits to the furnace, where they are shovelled out of the wagons into the barrows. In addition to this, they haul out from the furnaces all the cinders, and deliver them some distance.

CALCINING OF IRONSTONE.—Conspicuous in the furnace plant are three large circular calcining kilns within a few yards of the three furnaces, and running parallel to them. A few years ago the calcination was accomplished in open mounds, exposed to all kinds of weather. Great advantage has accrued from the adoption of the new system. The mine is calcined more regularly, one-fourth the fuel is only required, and the immense labour in the shape of men and horses is saved. Two of these kilns—which are about 40 ft. in height, 24 ft. in diameter inside at the top, and 9 ft. at the bottom—will supply ironstone to carry on two furnaces, making from 220 to 250 tons of iron per week each, the ironstone yielding about 40 per cent. of iron. The arrangement for hauling up the wagons on to the top of kilns is simple. An engine is fixed behind the kilns, and winds the wagons with a drum and wire-rope. The boilers of this small engine are heated with the gases from the furnace.

BLAST-ENGINES AND BOILERS.—We were very pleased with the two blast-engines; they are of great power and size. The steam-cylinders are 45 in. diameter, and the blowing cylinders 87 in. diameter, 8-ft. stroke; the two engines are connected to one fly-wheel, weighing about 20 tons. We understand that these engines are about 13 years old, and were fitted up by the engineer of the works, Mr. P. A. Millward. From the amount of work they are doing with such ease and smoothness great credit is due to the engineer. They are supplied with steam from five boilers, which are all heated with the waste gases from the furnaces.

FURNACES.—Looking at the furnaces, of which there are three, two only in blast, from a short distance, they appear comparatively lifeless, in the absence of smoke clouds and the lurid glare of flame which in the past has so characterised the Black Country iron works. On nearing the plant, however, we soon perceive busy hands at work, and evident signs of vitality in the sombre looking structure. Knowing something of the capabilities of these furnaces, we were surprised to find a lack of busy excitement. A few men about seemed to have a definite work to do, and they did it. A thorough good system seemed to prevail in the apportioning of a certain department of work to a certain number of men. The furnaces are about 45 ft. in height, if we remember right, and about 15 ft. in the boshes. The average quantity of forge grey pig-iron made at each furnace per week is 230 tons. We are told that 250 tons per week per furnace have been made. These results, which are above the average of the district, are attained by the economical management of every detail in connection with the smelting of iron. The mineral flux and fuel are as equally distributed in the furnaces as can be, and as required. The waste gases are regularly taken off by a system which we think preferable to all others adopted in the neighbourhood. The furnace hearth is improved in shape, and, although not like Lurman's system of "close hearth," answers in part as well. The system for taking off the waste gases is an improved method invented and patented by Messrs. Addenbrooke and Millward. The principle seems to be this, or rather the advantages of the system—"The whole height of the furnace-throat is left free for charging, which is equivalent to giving additional height to the furnace in comparison with other modes of taking off the gas. The top of the gas openings being 4 ft. below the top of the furnace, as long as the materials are kept charged up to within 3 ft. 6 in. of the furnace top no damage can be done by flame to the gas apparatus, except by carelessly allowing the chimney-draught to be so strong as to take off more than all the gas, and consequently draw in some air from the furnace top. There is no wear and tear from the shocks of the successive barrow loads of material charged, which do so much damage to a cylinder carried upon brick arches, or a bell suspended in the furnace throat. From the great strength of the castings forming the gas openings into the arch which surrounds the furnace, and their advantageous situation, next to no repairs are required, and there are consequently fewer stoppages, and an increased make of iron is the result." Such are a few of the advantages of this system as superseding the Darby bell method, which was formerly adopted at these works. It was found that the bell, which hung 4 or 5 ft. in the top of the furnace, often required repairs and renewing, besides taking up so much furnace room. The gas-mains are 5 ft. diameter, the chimney 10 ft. diameter inside throughout, with a height of 160 ft., the main flues to the chimney 5 ft. high to the crown of the arch, and 4 ft. 6 in. wide. The hot-blast ovens are built on the improved Barrow system, containing nearly a weight of 100 tons in pipes, which are so arranged as to expose a large area of heating surface; and provision is made for the expansion of the metal, the want of which in the old bugle style of pipes caused so much breakage and leakage of air. With the former oven the heat of blast can at these works be kept up to 1000° Fahr., requiring no repairs for years, while in the latter it would be difficult to exceed 800°, which would require repairs every few months. These ovens are heated by the waste gases from the furnaces, as are the blast-engine boilers.

Another new feature in this district we noticed in the shape of the cinders, or slag. We could not see any of the ugly "oyster" species, which so terrified the stranger, who, in his blissful ignorance, was made to believe they were gigantic fossils of the oyster tribe. The slag is run into square boxes, the base of which is formed by a movable wagon, on which the cinder rests, and is taken away after consolidation; this method is more economical than the old one, and gives more room and tidiness about the furnace.

Our next inspection was something closed up in a box, out of the base of which came out showers of stone—limestone. We were facetiously told that whatever or whoever happened to get into the opening at the top was sure to come out in small bits. We, of course, remembered the caution, and very cautiously examined the "Blake's limestone breaking machine." It appeared to do its cruel work with a relish. This machine can break as much stone in three days as the regular set of men with hammers could do in a week; it requires little labour, and saves much. The works can also boast of a line of fitting shops, where they do all their own work in the engineering department. The two locomotives were made on the ground. Everywhere around there is the appearance of wisdom in scientific application of improvements and economic management. We were very pleased with our round of inspection, and can only say that whoever wishes to visit these works with a proper object in view will, doubtless, like us, meet with respect and intelligence.

We afterwards strolled through other and adjoining works. Messrs. Wm. Ward, from New Priestfield Iron Works, are in much respect similar to the works described; Messrs. Fletcher and Solly's plant, too, is well worth a visit.

F. G. S.

IRON WORKS AND COAL MINING—MONMOUTHSHIRE.

TREDEGAR IRON WORKS.

SIR,—These works comprise blast-furnaces, forges, and rolling-mills, brick works, coke ovens, and workshops. To supply these manufactures with coal and ironstone about 22 pits and levels are in operation, being planted over about five miles of country from north to south. The royalty is owned principally by Lord Tredegar. These extensive works are carried on by Messrs. Forman and Fothergill. The railway from Risca up the Sirhowy Valley is also under the same proprietorship, and forms the communication between the works and Newport for the exportation of iron and coal. The distance from Tredegar to Newport is 19 miles.

BLAST-FURNACES.—There are nine furnaces erected, 45 feet high, and 16 to 17 feet in the bosh, but the width is increased greatly by continued use. The first furnace was erected in 1802, and others have been added at various times. Seven of the furnaces are now in operation, making hot-blast iron; they are closed at the top by cup and bell; the gases are utilised in heating the blast-pipes and boilers. It is considered these furnaces might with advantage be raised to 60 or 65 feet high, the result would be a reduced consumption of coal and coke, and increase in make, though the materials used are not of sufficient strength to bear large burdens. The ores used are Welsh mine, hematite, ores from Northampton, Myndy, Forest of Dean, and Spain; these are mixed with equal quantities of coal and coke, and proportioned to the quality of iron required. The mine kilns are built behind the top of the furnaces, and 300 coke-ovens behind these. There are five blowing engines erected to supply the furnaces and refineries with blast. Three of these are at present in operation, viz.:—No. 4 engine, 42-inch steam cylinder, 10-ft. stroke; 120-inch blowing cylinder, 10-ft. stroke, goes 16 strokes per minute, at this rate will blow 25,132 cubic feet per minute, six high pressure boilers heated by gas only. No. 1 engine, 40-inch steam cylinder, 7-feet stroke, condensing, going 18 strokes per minute, without fly-wheel; blast, 3½ lbs. pressure. New engine, erected 1860, 57-inch steam cylinder, 13-feet stroke; 144-inch blowing cylinder, 12-feet stroke, going 13 strokes per minute; fly-wheel, 50 tons weight; connecting-rod between cylinder and centre; 10 high pressure boilers, heated by gas and coal. At this rate of going is capable of blowing 35,286 cubic feet per minute. No. 2 engine, not at work, 50-inch steam cylinder, 8-feet stroke, low pressure. Another smaller engine, standing. The three engines supply blast to five double refineries, as well as the furnaces.

FORGES AND ROLLING-MILLS.—The forge was originally used as a forge and mill, and commenced about 40 years ago; the new mills having been since erected, the whole of the old part is devoted to puddling. There are 80 puddling-furnaces and four forge trains. Two trains driven by the old beam-engine, 36-in. cylinder, 8-ft. stroke, condensing, on second motion, has been in operation 40 years. Two other trains are driven by a 33-inch horizontal-engine, 4-ft. stroke, direct action, high pressure, one squeezer to each train, and one engine and pair of shears for each. The heat from 14 of the puddling-furnaces is conveyed through culverts to generate steam in three boilers, the boilers being set in brick-work in the ordinary way. One other boiler is heated by coal. This plan of heating boilers by waste heat is considered a very safe one, it is not found to be any detriment to the make of iron, and when properly arranged at the outset must be attended with considerable economy. The older portion of the mills consists of two rail mills, two mills for blooming, and one mill for merchant iron. These five are all driven by one engine, of 45-inch cylinder, 8-feet stroke, beam construction, 50 lbs. steam pressure. There are nine boilers, heated by coal. There are two small engines for driving two saws and a pair of shears. There are 35 balling-furnaces erected, each has its own stack. A new merchant-mill and a guide-mill have lately been added to this part of the establishment; these mills are driven by a 28-in. horizontal-engine, 3-ft. stroke, 40 lbs. pressure. There are seven balling-furnaces here; these are without stacks. The waste heat from the furnaces is conveyed away by a culvert, and heats two boilers, set in brickwork, near them, in a similar manner to those described in the forges. The other engines in operation at these mills comprise—one engine for 12 presses and two large shears, two small engines, each for a pair of shears, one engine for punches, and one engine for shearing and bending cramp-iron. The iron manufactured for sale consists altogether of rails and railway iron, and amounts to from 1000 to 1100 tons per week. The quality of iron to produce rails having a uniform and sound upper surface is carefully studied at these works. We may say that puddled bars of almost any quality may be made according to the selection of ores used, even with hot-blast; and this, again, is influenced by the coal or coke used in smelting, as one description of coal will help to produce a good quality of iron, while another description will deteriorate it, so that it is important to have an analysis of all the coals, as well as the ironstone, used in smelting, in order to select those best adapted for making pig-iron, puddled bars, and rails in the final process, of uniform and durable quality. The principal requirement in a rail is that the head should be of a hard and homogeneous nature, so as to be capable of standing a large amount of use.

COLLIERIES WORKED IN CONNECTION WITH TREDEGAR IRON WORKS.—The total output of coal from the collieries is about 1650 tons daily; about half is sent to Newport for shipment as large coal, the remainder is used for manufacturing purposes at the works. About 2000 tons of mine is raised per week. Commencing at the south end of the property, the principal establishment is the Bedwelty Pits; these have been in operation about 14 years. There are two pits sunk, about 20 yards apart, 16 by 11 ft. in section, one downcast, one upcast, depth 230 yards to the yard seam; in both pits coal is raised—about 270 tons per day from each. The winding-engine at downcast has two 25-in. horizontal cylinders, 4-ft. stroke, direct-acting, 9-ft. rope rolls; winds from 230 yards depth. The upcast winding engine has one 28-in. horizontal cylinder, 6-feet stroke, cog-wheels 1 to 2, rope rolls 9 ft. and 10¼ ft. diameter; one band 230 yards to Yard seam, one band 202 yards to Elled seam. The pumping-engine cylinder is placed over part of the downcast pit; 50-in. cylinder, 9½-ft. stroke, going four strokes per minute day and night; the piston-rod works underneath direct to the pump-rod; to this are connected four forcing sets—14-in. rams—raising water from the depth of 240 yards; each set is about 60 yards of column. Six plain boilers supply these engines with steam, 50 lbs. pressure.

METHOD OF WORKING.—From the bottom of the downcast the west level is driven about 600 yards, and the east level the same. From the west level, 100 yards from the pit, a pair of dips are driven a considerable distance to the full dip south. The dip averages about 3½ in. per yard Two cross-dips are turned out of these, going south-east, 60 yards apart; and others will be turned away as the main dips proceed, at the same distance. The Yard coal is being got by long wall work on both sides of the main dip, the gate-roads being 16 yards apart; the breadth of face taken by two colliers, usually called a stall, being 16 yards. On the east side the roads are turned away from the cross-dips, going a little to the rise, a few points north of east, 8 or 10 yards of coal is left to support the cross-dip in commencing. The long wall work on the west side of the dip is laid out in a similar way, but a pillar of greater breadth is left next the dip. In working the coal eastward back slips are crossed; in working west face slips are crossed; the latter are generally the most advantageous, but it is not of much moment in which direction they go.

SECTION OF THE BIG VEIN AND YARD COAL TOGETHER.

		ft.	in.		ft.	in.
	1.—Shale, with balls of mine.					
Big vein—	2.—Top coal	3	4			
	3.—Shale parting	0	0¼			
	4.—Bottom coal, hard	2	0	=	5	4¼
	5.—Clod, with balls of mine				4	0
Yard seam—	6.—Coal, good	3	0			
	7.—Rashes	1	0	=	4	0
	8.—Underclay.					

The Yard coal is got first by long wall, as described. The clod No. 5 is taken down in the gate-roads for height, and furnishes the pillaring and part stowing up behind, the remainder of stowing is got from re-cutting the roads; the bottom coal, No. 4, forms the roof. While the faces are being driven this bottom coal, and the upper part of the Big vein is partially taken down to make height, when the gate-roads have reached 60 yards, the Big vein is then got by working back in sections, commencing at or near the inner end; the coal is brought out by the same roads in the Yard seam; the most of the Big coal is got by this process. Half of the coal raised is got from each seam. The mine in No. 1 and No. 5 beds is got to some extent. The dip and cross dips before named are designed to be worked by an engine only, without horses, the empty trams to run into each with the rope. The engine will be placed above the west level, and will draw the full trams out with one drum, past the level, and drop them back to the pit; the empty trams will be worked the contrary way; 8-in. pipes are fixed in the downcast pit, to supply this engine with steam. The upcast pit is supplied from the Yard seam by a self-acting incline, 550 yards long, and levels upon that. The Elled seam is landed 28 yards above the Yard seam; it varies in thickness from 2 to 6 ft., is got by the long wall system entirely.

VENTILATION.—One furnace, 8 feet wide, produces a circulation of 73,000 cubic feet per minute; it consumes 59 tons of coal per week, equal 5615 cubic feet of air per lb. of coal used; three men per day attend the furnace, eight hours each. The distribution is to the west district, three splits, 43,750 cubic feet; east drift, one split, 16,000 cubic feet; Elled seam, one split, 13,200 cubic feet: total, 72,950 cubic feet. The water-gauge shows 2 3-10ths of an inch at the furnace doors. The colliers work altogether with candles in those pits; powder used, but not generally required. The explosion which occurred at Bedwelty in 1855, in the Yard seam, caused the loss of 26 lives. An accumulation of gas at the top of a cross-heading, which was known to exist, by some unknown cause exploded, though the men in the stalls near to the accumulation were using Davy lamps. This is another proof of the danger of allowing an accumulation of gas to stand, instead of suspending the working of the colliery until it is swept away; and points to the origin of most of the explosions which have lately occurred. Not only should accumulations of gas be thus got rid of, but the greatest watchfulness is required to prevent them occurring in unknown positions, either in goaves or abandoned workings. There are 26 horses employed in the Bedwelty Pits. The trams are iron, close-bodied, and carry about 1 ton of coal; 14-in. tram-wheels, run on wrought-iron tram-plates, 4 feet long. The carriages in the downcast run on two wooden guides, those in the upcast on three wire-rope guides.

THE PONTYGWAITH SEAM.—This is worked by level, about 80 yards above the top of Bedwelty Pits. The coal averages 2 ft. 9 in. thick; the Pennant rock lies upon it, the roof is, therefore, of great strength. The coal is worked by wide cross-headings, 10-yard stalls and 10-yard pillars of coal alternately; about 150 tons of coal per day are got from this level; it is sent by a self-acting incline to the railway siding on carriages. Work the same seam from a level at Hollybush, one mile lower down; get about 40 tons per day. There are 75 coke-ovens at Bedwelty. The Pontygwaith coal is mixed with the less bituminous coals drawn from the pits, for coking in the ovens here and at the works.

TY TRIST PITS.—These are situated near the Sirhowy Railway, about one mile north from Bedwelty. There are three pits near together; one is used for raising coal by water balance, 100 yards deep to the Yard seam. The Yard and Big veins are worked. The get is about 350 tons per day. At the Middle Pit the water is raised by a 16-in. beam engine, having a connecting rod and T bob attached to the pump rod; part of the water runs to the Bedwelty engine. An engine is now erected at the North pit, which will draw with two bands in the same pit, one from the Yard seam (100 yards), the other from the Old coal (200 yards deep); this will supersede the balance pit, and dispense with the pumping engine. The pulley-frame is being erected of angle iron, cross braced. The winding-engine has two 25-in. horizontal cylinders, 4 ft. stroke, one drum 10 ft. diameter, direct-acting, for the Old coal, and one drum, 10 ft., for the Yard seam, motion reduced by cog-wheels 1 to 2. A hauling-engine underground in the Yard seam raises coal up a plane 1200 yards down to south, by one drum, two horizontal cylinders.

NO. 11 MINE PIT.—This is planted about 88 yards above the Ty Trist pits, 150 yards deep to the Black Pins Mine; it is the upcast for Ty Trist, and mine and rubbish are raised by water balance. Water goes to the pumping-engine. This pit is situated on the upper locomotive road, on a level with the top of the blast-furnaces, and adjacent to this road most of the balance pits hereafter mentioned are situated. Four small tank locomotives, running on tram-plates, 2 ft. 10 in. gauge, convey coal and mine to the furnaces, and coal to the screens at the coal yard, near the top of the great incline. These locomotives also convey limestone from the Trevel Quarries to the blast-furnaces.

OTHER COAL AND MINE OPENINGS.—No. 8, coal balance pit; 100 tons per day raised from the Elled, Big vein, and Yard seams. No. 9 pit, balance; black pins raised. Ash Tree balance pit; the Elled, Big, and Yard seams worked. The Forge Drift; this is driven in the Old Coal to the dip; the coal is hauled by two engines at the mouth, situated near the mills, at which it is consumed. One engine hauls with two drums, on a plane 500 yards long. The trams ascend and descend together, the road is double. From the bottom of this two engine-roads branch off, one to the dip, the other half course, about 1200 yards in length; out of these levels and cross-headings to the rise are driven at regular distances. One engine works the two engine planes, with one drum, and rope from the top. About 180 tons of coal are raised per day from the Old coal. The seam varies from 6 ft. to 11 ft. thick in four beds. The following is the usual section in this drift:—

	Ft.	in.	Ft.	in.
1.—Coal	3	0		
2.—Clod			4	0
3.—Coal	2	6		
Parting.				
4.—Coal	2	0		
5.—Clod			1	0
6.—Coal	3	0		
	10	6	5	0

Nos. 4, 5, and 6 beds are first worked in stalls, No. 3 forming the roof; Nos. 1, 2, and 3 are obtained after the stalls are driven 60 yards in working back. The water met with in the workings is raised by tubs up to a certain point, where it runs off to a pumping-pit. From the Yard balance pit the Elled and Bedelleg coal is raised. The Yard level work Elled, Big, and Yard seams. No. 5, or Globe Pit, balance, raise engines and Yard coals 80 tons per day; also spotted, red, and blue mines. No. 4, or Brigg's Pit, balance, raise old coal 50 tons per day, and the same mines. Mountain Pit, balance, raise Yard coal, also spotted, red, and blue mines; a Cornish engine erected at this pit. No. 2 Balance pit raise yard coal, also big, spotted, red, and blue mines. No. 3 balance pit raise old coal, and the same mines. No. 1 balance pit raise the same as No. 3. Some of the balance pits, it should be observed, have a free water-course at the bottom, others, the smaller portion, require the water to be raised again by pumping. Besides these, there are six levels from which coal and mine are got, and large patches, from which 50 tons of coal per day is got, and 10 tons of mine; and limestone quarries at Trevel, from which 150 tons per day are got.

THE WORKSHOPS.—These are built on an extensive scale. There are two smiths' shops, with 40 fires, the blast supplied to them by a fan and engine. The fitting-shop contains 25 planing, turning, and boring machines, all driven by a 12-inch beam engine, 3 feet stroke,

There are other machines, apart from these, making the number 35 altogether. There are pattern makers and carpenters' shops, and a shop for making and repairing railway wagons, and extensive foundry. Locomotive and stationary engines have been made at these works, but this is not carried out to any extent. The materials for the supply of the works generally are raised from the Sirhowy Railway by an incline 600 yards long and stationary engine, to the level of the top of the furnaces. There are four locomotives, on the 4 ft. 8½ in. gauge, to convey materials from one department of the works to another.

LIST OF THE PRINCIPAL SEAMS AT TREDEGAR WORKS.

	Ft.	In.	Yds.	ft.	in.
Mine ground, 3 ft.; soap vein, 1 ft.	4	0			
Strata			8	0	0
Black Pins Mine ground	11	0			
Strata			32	0	0
Elled seam	4	0			
Strata			20	0	0
Big vein	5	0			
Strata			1	1	0
Yard seam	3	0			
Rashes and engines			1	1	0
Three-quarter coal	2	3			
Strata			29	0	0
Bedelleg seam	2	6			
Strata			30	0	0
Engine coal, mixed with shale	6	0			
Strata			9	0	0
Little yard seam, good	2	6			
Strata			30	0	0
Old coal seam	4	4			
Strata			2	0	0
Spotted vein pins.					
Strata			10	0	0
Red vein mine.					
Strata			3	0	0
Blue pins mine.					
Strata			9	0	0
Big vein mine, 7 ft. ground.					
Strata			3	0	0
Garrw pins mine.					
Garrw coal	1	10			
Strata			3	0	0
Millstone Grit series.					

M. B. GARDNER.

EXPERIMENTS WITH SAFETY-LAMPS.

SIR,—It is well known that common illuminating gas can be ignited by applying a hot iron bar, but fire-damp cannot be so ignited; and it is truly surprising what severe trials and tests have been applied to the Davy lamp in former days.

The first remarkable case I shall give is, I believe, correct as stated, although it hardly appears to be credible. I must, however, remark that, though I cannot personally vouch for its truth, I obtained the particulars from several witnesses. Two men were boring in an advance drift in a colliery near Newcastle, when they suddenly holed into old workings, containing a quantity of gas of some kind under pressure, but no water; the pressure of the gas forced the bore-rods out of the hole, and so alarmed the men that they made a hasty retreat, and in their haste they left a Davy lamp burning near the face of the drift. On their way out of the workings they met the underviewer, and of course informed him of what had taken place, not omitting to state that the safety-lamp was burning in the drift. He, of course, feared an explosion, but decided to proceed to the face of the drift, and the men accompanied him there; and on their arrival at that point they found the lamp, or rather the remains of it, for it was almost entirely destroyed. The gauze was entirely destroyed, and other parts of the lamp were also consumed, the solder melted, &c. There had evidently been great heat present, sufficient, as stated above, to destroy almost entirely the lamp, but there was no explosion. What was the nature of this gas? Was it sulphuretted hydrogen? Perhaps some of your correspondents versed in chemistry may give some explanation of this curious case. No doubt it has some peculiar mixture—pure sulphuretted hydrogen will, I believe, hardly support combustion.

Another case may be mentioned which shows that the Davy is an awkward instrument, when it happens that the lamp is filled with flame, and where it is not possible to remove it from the inflammable atmosphere immediately. Two men travelling in a remote part of a mine with Davy lamps suddenly and unexpectedly encountered an explosive current moving at a considerable velocity, which filled their lamps with flame. The lamp wicks were pulled down, but without effect, the gas continuing to burn within the lamp; and this continued for a considerable time, the combustion which went on being something terrible. When at length they reached a clear atmosphere the lamps were so much heated that the walls and roof were quite visible from the light given out; and when the gauzes of the lamp were examined on the surface they were so much burnt as to be easily crumbled to dust by the fingers; the iron was quite destroyed. Now, this was a current of gas moving at a considerable speed; but I am sorry that I cannot give the speed.

It must not be supposed that this was a similar mixture to that met with in the last case, as it was well known that a considerable quantity of fire-damp was standing in a portion of open workings; and indeed the men alluded to were engaged in carrying the air round these workings, so as to clear out the gas. M. E.

THE CHEMISTRY OF THE MINE.

SIR,—Having read Dr. Hill's lecture on the "Chemistry of the Mine," recently delivered by him at Walsall, and whilst gratified to find so much interest taken in the subject of gases met with in mines, I must say that I have not seen, in a practice extending over very many years, a case in which a workman could hold his candle for a moment near the roof, and by so doing produce a slight explosion, and then by holding it near the floor extinguish the flame. That is too fine a point for a coal mine. Dr. Hill says:—

"The temperature required to ignite inflammable gas differs very much, and fire-damp requires a higher temperature than most others. This is a very favourable circumstance in connection with the construction of the safety-lamp, and accounts for the fact that in making very urgent explorations in an explosive mixture of the gas the Davy lamp may continue to be used when red-hot; but this, of course, should only be done under the most urgent necessity, as for instance, the rescuing of life when in imminent danger."

To this I can only reply by saying that Sir H. Davy states that he found "that iron wire-gauze, composed of wire 1-40th to 1-60th of an inch in diameter, and containing 28 wires, or 784 apertures to the square inch, was safe;" but this was in a still current, and in giving his lamp informed those who were to use it that there was no danger or hazard, excepting in exposing it to a strong current, by which the explosion would be passed through the gauze. It is now an acknowledged fact that there has been too much reliance placed on the Davy lamp. I do not approve of men being allowed to work in a place where the lamp is found full of fire, or red-hot, all day long. The men ought to know that the lamps should not continue to be used until they become red-hot, but should be required to leave the place when there are indications of gas, and not return until it is removed. They have had sufficient proof of too much reliance being placed in the lamp, to the serious neglect of the ventilation of the mine. The Doctor again says—"A red-hot solid body will not inflame a mixture of fire-damp and oxygen."

Now, Sir, with the consent of Mr. Woodhouse, at the Oaks Colliery, Mr. Hutchinson, and several others, in August, 1867, with the gas coming out of the pit, tested the various lamps—the Davy, Clanny, and the Stephenson, which all exploded. The gas also was lighted by a hot iron after leaving the blacksmith's shop and being conveyed to the place where the gas-pipe was fixed in 16 seconds and up to 83 seconds. The pit's gas was afterwards lighted with red-hot gauze. At the experiment made at Barnsley most of the lamps in use were tested with a current going at the rate of 21 miles per hour when the Davy exploded in 5 seconds; the Clanny, 8 seconds; the Stephenson, 23 seconds; the Belgian, 1 minute 30 seconds; and the Mozard, 1 minute 30 seconds. At a current of four miles per hour the Davy lamp fired in 7 seconds; the Clanny, 6 seconds; the Belgian, 15 seconds; the Stephenson, 1 minute 19 seconds; and the Mueseler, 12 seconds. So much for the use of red-hot Davy lamps.
A COLLIERY VIEWER.

NORTH TRESKERBY MINE.

SIR,—As the manager of North Treskerby Mine, I think it right that the shareholders should be informed that the statements which are in circulation, to the effect that this mine will suffer from an increase of water, consequent upon the contemplated stoppage of some of the neighbouring mines, are without foundation. There is not the slightest cause for alarm in this respect, and the rumour is evidently merely circulated by certain interested parties to suit their own purposes. It is a great pity that shareholders should be imposed upon in this manner, and thus frightened out of their shares, and I am sorry to say that there are parties who are doing their utmost to assist these disgraceful operations. I am very pleased to state that the mine is looking very much better than it has done for years, and the recent discovery in the Doctor's shaft in the new ground, and the steady improvements which we have had for some time in the levels driving east, cannot fail to be most cheering to the shareholders, and to convince them that North Treskerby will soon again occupy a very different position.—*Redruth, Cornwall, Nov.* 17.
RICHARD PRYOR,
Manager of North Treskerby Mine.

COPPER MINING IN CORNWALL.

SIR,—After the gloom cast over the district between Marazion and the important and flourishing port of Hayle by the suspension of the Prosper United Mines, throwing out of employ several hundred persons, many families are said to be in a state of almost starvation, and this on the verge of winter. Merchants as well as shopkeepers are put to their wit's end; the latter know not how to supply these poor families any longer, as they are much in debt, and little or no more credit can be given them.

At last, however, a gleam of hope seems to have sprung up in the neighbourhood the last few days, from a wide-spread report that the Wheal Jewell and Tregartha Mines, at one period of great repute, are to be worked by an influential company, under the management of Mr. Absalom Bennett, a gentleman who has done so much good for the neighbourhood by bringing an immense amount of capital into Cornwall during the last 20 years, and more particularly in this district. It is also stated that the landowners have met Mr. Bennett's appeal to them on liberal terms, and without which very little good can be expected in the district. At one period the district between Camborne, Hayle, and Penzance yielded immense returns of the richest description of copper ore, and thousands were paid in royalty to the lords, and some families realised very handsome incomes.

The very great depression during the last few years in the price of copper, owing principally to importations of rich ores, the deep mines of Cornwall and Devon had no chance with such competition; consequently, several of the oldest and richest mines, in days gone by, have been abandoned, and once populous villages nearly deserted, thousands of persons annually emigrating to distant lands from want of employment.—*Nov.* 16. A WELL-WISHER.

ON THE ASSAYS OF SILVER ORES—No. III.

SIR,—A misprint occurs in my last letter (No. II.), which requires correction. A few lines from the end, for "*quantitative*" must be read "*qualitative*" (which makes all the difference in the world); and, about the same place, for "*this* silver" please read "*their* silver."

I regret to see that my letter No. I. (Nov. 6) has given rise to four angry communications, written, apparently, by gentlemen connected with some mine in Cornwall, who accuse me of alluding to it in my letter of Nov. 6. But I need scarcely say that my remarks had reference to a purely scientific subject, and that no mine or mining company had anything to do with them. I stated that assays of a few grains of picked specimens lead to error when the results are *stated in tons* (as was the case in an editorial paragraph in the Journal of Oct. 29), as it causes the ore to be considered much richer than it really is, and misleads both proprietors of mines and the public. My remarks are applicable to all mines, and to all assays of ore. The error is a very common one. One of your correspondents is kind enough to say that my letter No. I. is a *libel*, and *calculated* to injure some mining company I never heard of, and of whose mine I know nothing! Such a ridiculous statement surely requires no comment.

Several persons have written to ask me what is the smallest amount of silver that can be worked profitably in England from any argentiferous lode, and whether 20 ozs. per ton would pay, provided that there was an unlimited supply of the material. This is a question, the solution of which depends upon so many and variable circumstances, that it is impossible to reply to it categorically, or in a general manner. We must consider the cost of raising 1 ton of the product, the cost of stamping, dressing, sampling, &c., the cost of carriage of this ton to the locality where the ore is to be smelted, the cost of material, wages, &c., used in smelting, and all this is to be placed against the value of 20 ozs. of siver—say, 5*l.* It is, therefore, a calculation which must be made individually for each mine, and no general law can be laid down as to the smallest amount of silver that it will pay to work. Another consideration which complicates the question is, whether the ore yields any other metal, such as lead or copper, as well as silver. By Pattinson's process it is said that 3 ozs. of silver in the ton of lead (metallic) can be extracted with profit, and gossans which give 4 to 6 per cent. of copper, and 20 to 25 ozs. of silver, are, I believe, readily saleable.

An eminent French chemist, member of the Academy of Sciences, has informed me that, according to his experience, which extends over many years, when a silver mine is properly worked it invariably yields a somewhat higher result than is shown by the usual dry assay. I am not surprised at this announcement, which will appear encouraging to owners of mines the ores of which yield a low percentage of silver, for it is well known that silver is volatile at a comparatively low temperature; and in assaying ores of 20 to 40 ozs. per ton there must be, unless very great care is taken to keep the temperature as low as possible, a notable amount of loss. The smaller the yield the greater will be the loss by volatilisation, hence the curious result communicated to me by M. Henri St. Claire-Deville; hence, also, the somewhat greater accuracy of the wet method of assay, when applied to poor descriptions of ore. T. L. PHIPSON, Ph.D., F.C.S.,
Member of the Chemical Society of Paris.
Analytical Laboratory, Putney, S.W., Nov. 17.

OLD TREBURGETT—RICH SILVER ORES.

SIR,—It is, no doubt, surprising to many of your readers that such rich ores should have been overlooked in former workings, but I have known other mines in this county producing rich silver ore, that was thrown away at the time as being worthless (even put to repair a road), and which took place not a great many years since. Again, it is more surprising to know that mines being worked for copper threw away tin of value unrecognised, for there are many miners who are unacquainted with tin; and I am quite sure there are very few who know anything of silver ores, and especially of "polytelite," which is a variety of tetrahedrite, rich for silver, and of rare occurrence in Cornwall. At Great Crinnis, some years since, tetrahedrite was found in considerable quantity, but I know of no mine of late years that produced such quantities of this mineral, and of such value, as Silver Vein, near this place, though there are other mines that produce it in less quantity, and of less value, in some of which only traces of silver could be found.

I have devoted my life from a boy collecting minerals, and, therefore, I am acquainted with the above district, and I have no hesitation in saying that it is congenial for the production of silver ores, and that there are other lodes in the immediate locality that will be found to produce it, and should not be lost sight of, this part of the county having been too long neglected already. R. TALLING.
Lostwithiel, Nov. 16.

THE ASSAY OF SILVER ORES.

DR. PHIPSON, AND OLD TREBURGETT.

SIR,—Before a man takes upon himself the office of public censor of other men's actions he should look well to his own, lest it should appear that he falls under the condemnation of his own censure. Dr. Phipson affords a striking instance of this simple want of precaution. In his haste to condemn the promoters of the Old Treburgett Company for stating the result of an assay of silver ore by the number of ounces of silver to the ton of ore, and to expose, forsooth, their insidious designs upon the public, in so doing he seems to have forgotten that only a few months before he did himself, in a letter which appeared in the *Mining Journal* of July 3, express the results of assays of silver ores made by himself precisely in the same manner—by the number of ounces of silver to the ton of ore, and that repeatedly in the same letter, as anyone may see by referring to it. If the Doctor should say that his statements in that letter were not made in the interests of a company, and, therefore, that no one could be deceived or led astray by them, those who drew up the reports of this company may emphatically, and with a clear conscience, make the like assertion, for they have fully provided against the possibility of anyone, possessed of a grain of common sense, being deceived or led astray by their statement, as has been abundantly shown in the correspondence in last week's Journal. It is difficult to conceive what motive could have urged the Doctor to make this gratuitous and unwarranted attack. One could imagine that the furor of some private pique had deprived him of his head for the nonce; like Goldsmith's dog, who ——"to gain his private ends
Went mad, and bit the man."

I feel confident, Sir, that this mine will clearly demonstrate in the course of its development—and that by the best of all evidence, the return of profits it will make—that its promoters, so far from aiming to overstate its claims, have made their statements with an over-cautious reserve. I am not one of those promoters, but I know them to be men of honour and strict integrity; and relying upon this, and upon what I know of the merits of the mine itself, I have taken a large interest in it as a shareholder, not as a speculation, but as an investment, which I am sanguine enough to hope and believe will, at no distant period, repay me well.

The re-opening of this mine is in many ways an interesting experiment, and claims the support of all who feel interested in British mining, whether as an investment or in a scientific point of view. As a means of investment, it is taken in hand under most favourable auspices, comparing the former character and success of the mine, as a lead mine simply, and the character it has now assumed, on the most positive evidence, as a silver mine and a silver-lead mine in one, and the far greater success that may consequently be fairly reckoned upon. It is interesting, too, as probably leading the way to the opening up of a new field in British mining, one that has been much neglected, but which promises, through the more accurate knowledge of minerals we now possess, to be one of the richest in the kingdom, and, perhaps, even to rival some of the famous mining districts of the New World; for the opinion expressed by men of science, that the silver ore will increase in richness and quantity the deeper the lode is worked, should be well weighed and considered. And, further, it must be an experiment deeply interesting to the geologist and mineralogist, the opening up of a lode of so peculiar and, I believe, unique a formation, having a vein of silver-lead ore in its centre, and quartz, capels, or sidings, abounding in silver ore of great richness, lining its sides. The study of this formation may possibly throw some light on the formation of silver-lead lodes generally. There is scarcely any other formation in the kingdom that offers so many points of interest, or so fair a promise of reward for the working, as this of Old Treburgett does. J. B.
Bristol, Nov. 16.

MINERAL WEALTH OF SPAIN—No. IV.

SIR,—In concluding my last letter I promised, with your kind permission, to give the text of a Bill, now under consideration in Madrid, the object of which is to declare free from taxation during a certain time and to conceds certain exemptions to new industries which may be established in Spain. For the translation I am indebted to the Spanish Consul here, and he being thoroughly convinced that its publication in England will be advantageous to Spain, has spared no labour in the matter:—

Article 1.—Whatever new industry may be established in Spain shall be declared exempt from all contributions for the term of 15 years. Any manufacture that creates products that were not elaborated in this country before, or any employment that produces such products from raw materials that have not been utilised for the same object, shall be reputed new within the terms of this law.

Article 2.—When any process radically different to anything before employed to obtain such products is applied, that industry shall be exempt from all contributions for the term of five years. Whatever may be the new mechanical works required in the application of a process radically different from any that has been employed before the conclusion of the term of exemption, which term will then be extended to ten years, these industries will not be burthened with more contributions than will satisfy the tariffs of subsidies in force at the date of this law being published.

Article 3.—All new applications as motive-power of water which is running to waste may be applied to the industry for which it is utilised, and in the case of those embraced by the former articles shall be exempt from any impost for three years, which may be increased according to the terms of articles 1 and 2.

Article 4.—Edifices constructed exclusively for carrying on new manufactures, and not comprehended in existing tariffs for industrial and commercial subsidies, will be exempt from all contributions for ten years.

Article 5.—The Government will grant, at a fair valuation, to any private person or industrial company to whom this law applies, subject to such guarantee as the Government shall demand, any lands of the State or of corporations being uncultivated or royal property, or land that can be occupied for the utilisation of the water as a motive-power, or for the construction of edifices and their dependencies. These lands are to be paid for upon the same terms and conditions as other State property. The valuation must be verified by a land surveyor named by the administrative power, and another by the person, company, or industrial body; and if any dispute should arise the corporation of the town within the radius of the estate shall appoint a third as arbitrator, and his valuation and decision shall be considered final.

Article 6.—It shall be declared that all machinery, tools, and instruments necessary for any of these new industries or processes be free of import duty for ten years, or for five years, or according to the articles 1 and 2.

Article 7.—All parties employed in any new industry by a private company or by persons, such as clerks, managers, and operatives, shall be entitled to the benefits arising from the use of timber in the vicinity of said works, as also from pastures, or any other benefits common to the public in the town where they shall establish themselves.

Article 8.—Any company or private person granted the benefit of this law shall be entitled to construct edifices and works necessary for the industry they propose to carry on, as well as dependencies necessary for the same, or habitations for the workmen; and shall have the faculty to open out quarries, gather or get loose stones for buildings, construct lime and bricks kilns, &c., and deposit any materials on the public grounds, advising the local authorities of the same; the same may be done with any private property, upon giving the necessary notice to the owner or his representative through the medium of the "Alcalde" of the district, and undertaking to pay all damages and injuries.

Article 9.—The conveyance of edifices and lands acquired for the industries comprised under articles 1, 2, and 3 will be exempt from hypothecation duty.

Article 10.—Whenever any manufactories are erected outside the fiscal radius of the population they shall be exempt from all payment of the tax called "Impuesto de consumos, personal o de capitacion," whatsoever may be the form in which it is collected.

Article 11.—The Director-General of Agriculture, Industry, and Commerce shall publish during the present year the statistics of the industries that exist in Spain, explaining, if possible, the processes and the mechanical systems that are employed; a new edition of this work will be issued every three years.

Article 12.—The movable or fixed property and the capital of all foreigners dedicated to the establishment of these industrial enterprises shall have the special protection of the State, and they shall be exempt from all reprisals, embargoes, or confiscations in the time of war.

Article 13.—Industrial companies, or private persons who seek to take advantage of the present law, must apply to the Minister of Trade and Commerce, who will grant the protection required, and will cause the same to be circulated, and give his authority for the exemptions which they may claim, and for the exercise of the rights which may be conceded to them.

Article 14.—The terms especially named in this law will commence from the date the orders to which reference is made in the preceding article, and through no other channel can the law be availed of.

Article 15.—All Governors of Provinces shall give all protection possible within the limits of their authority to all such industrial enterprises; at the same time, they will take care to prevent any frauds or abuses of any kind being committed under cover of these exemptions or rights.

Article 16.—The Government will publish the new regulations necessary for the execution of the present law within three months after this Act shall have received the sanction of the Constitutional Assembly.

Given at the Palace of Congress, Madrid, this 23d day of March, 1869,
EDUARDO GASSET Y ARTIME.

That the law will tend materially to encourage the introduction of new industries into Spain is, I think, beyond question; and I am sure that English capitalists will be found ready to avail themselves of any advantage offered. I am informed that the Bill became law in September last, but I have not received any papers announcing its enactment.—*Pendleton, near Manchester.* B. H. HOWARTH.

NEW QUEBRADA COMPANY.

SIR,—I observe with satisfaction the progress made by the directors during the past year to ameliorate the condition of this company, and the increasing interest which the shareholders, as a natural consequence, are beginning to take in everything relating to their property. My long connection with the company, and the interest I have always taken in its affairs, induce me to come forward to offer a few suggestions to my fellow-shareholders at this critical moment. It is admitted on all hands that the directors have proved themselves worthy of the confidence we placed in them, and it is now clearly our duty to give them that amount of support—moral and pecuniary—that will enable them to carry the operations of the company to a final and successful issue. They have introduced a company of contractors than whom there is none better in the kingdom—a company who will complete the contract to the satisfaction of all concerned. At the same time we have no right to expect that a company of the standing of Messrs. Waring will proceed with the works unless a substantial guarantee be given them. But this done, the shareholders may rest assured that success is certain. What we want is a line of communication between the mines and the sea; a line, be it understood, over which a sufficient amount of traffic can be carried to warrant ample returns upon the capital of the company. A railway alone will meet the requirements of the case. It must be substantially, but at the same time economically, constructed. Col. Strange informs us in his report "That the line being intended for mineral traffic only will justify the omission of many requirements which are essential for a passenger line, and so reduce its cost." At the same time he pointed out how the economising system had been carried too far, and I am inclined to believe that the expenditure on the section of the line already constructed must have been considerably greater than it would have been had it been substantially built in the first instance.

I need hardly say that it would be presumption now for any one to say a word as to how the works should be carried on. The gentlemen named by the board know their business too well to require suggestions from any quarter, and their experience in Honduras must have been valuable. But it must not be forgot that the shareholders have some preliminary duties to perform; and these are to unite and support the board, and subscribe for such an amount of the necessary capital as will constitute a sufficient guarantee to the contractors. To perform their part they will not have to submit to exorbitant demands. Indeed, I am satisfied the calls will be moderate compared with the returns we may reasonably expect. But what returns may we reasonably expect? I shall be glad if anyone connected with the management or otherwise will give me an approximate estimate. I have taken notes from the published reports, in order to work out this problem for my own satisfaction, but I hesitate to publish the result. We possess not only the largest but I believe the richest copper mine in the world; indeed, a mineral region of unsurpassed richness, and a vast tract of country capable of growing every kind of tropical produce. The more the property is examined the more we are convinced of its enormous value. Still attention has been almost exclusively directed to the railway, while the majority of the shareholders and the public are very imperfectly informed as to the present position of the mines and the quantity and quality of ore that could be brought down to Tucacas were the railway opened. Then, at what cost could the ore be brought down? We are entering upon a new era of the company's

existence, and certainly some such information is necessary. Some reliable information on these points will enable the shareholders to form some conception of the value of their property, and convince them of the necessity of making a final and successful effort to secure the rich prize that has so long eluded all their efforts.—*Manchester, Nov.* 17. J. M. R.

ROSEWALL HILL AND RANSOM MINES.

SIR,—As we are now nearing the next quarterly general meeting, in order to obviate the necessity of enforcing the 12th rule of the company, would it not be wise to publish with the notice of the meeting the name and amounts due from defaulters ?—*Nov.* 15. A SHAREHOLDER.

[For remainder of Original Correspondence, see this day's Journal.]

The Royal School of Mines, Jermyn Street.

MR. WARINGTON SMYTH'S LECTURES.

[FROM NOTES BY OUR OWN REPORTER.]

LECTURE III.—For a fuller account (said Mr. SMYTH) of the nature of the deposits referred to in my last I leave you to examine the standard works on geology. You will find in them much information with reference to the stratified beds now worked on so large a scale; but with regard to exceptional cases, which affect the miner and have less engaged the attention of geologists, it is also necessary that you should be acquainted with them. I have hitherto dealt chiefly with coal and with iron ores, but there are many other ores which occur in stratified forms, although it is necessary to be on our guard, lest we should bring things together which are essentially different. We must take care that we are not misled by appearances, inasmuch as deposits are often said to be stratified which are not so. This is not unfrequently the case with metalliferous ores which are alleged to be stratified, and which, no doubt, are frequently deposited with a much greater amount of regularity than might be expected. A succession of beds may occur in which a certain amount of parallelism is maintained, and which appear to have been deposited, not perhaps in the same moment of time, but in the same era, so that the whole range may be said to be contemporaneous. This is a totally different state of things to the commoner deposits of metals. They occur in a variety of forms amongst these strata, and often permeate them in the most irregular manner, in the shape of lodes or veins. There is little doubt that fractures of the bedded rocks have taken place subsequent to their formation, and the valuable minerals afterwards introduced into the fissures. This is plainly obvious in a vast majority of cases, but there are some of which it is difficult to say in what way they have occurred. The stratified deposits mostly present a great regularity over a certain area, and it is remarkable how some seams continue over hundreds of square miles. An example of this sort is furnished by the thin bands of copper ore belonging to the secondary rocks of North Germany, which extend over hundreds of square miles, and on which are the mines of Mansfeldt and Isenberg. There a band of copper pyrites, of very small dimensions, extends over the whole district, and, being highly argentiferous, the portion of silver in it makes it (although so small) worth while to work it in a scientific manner, so that miners in Prussian Saxony have been engaged on it for centuries. Amongst the risks which miners have to contend with in dealing with stratified deposits, I have mentioned principally the deterioration of thickness and the change of physical character. I also mentioned that occasionally a foreign material was found in the middle of a seam, and often prevailed to so great an extent as to render it scarcely worth working. A cognate difficulty not unfrequently occurs when the floor rises up towards, or actually meets, the roof. A ridge of that kind is called by the miners a "hog's back." The reverse of this sometimes happens when the roof comes down to the floor. These irregularities in some cases have manifestly arisen in the original deposition, but in by far the greater number of cases they are the result of disturbances to which the whole mass of rocks has been subject since their deposition. Another point of importance is that the miner will occasionally find a plane of division cutting through the beds, and shifting their position in a greater or less degree, varying from the one-tenth of an inch up to three or four thousand feet. This has often caused a great additional expense in working, but where the horizontality is maintained it presents no difficulty to the practised miner. This sort of thing is called a "pitch" or a "trouble." But if we come to a similar plane of division, and find on the other side no trace whatever of the bed on which we are working, and on which our hopes depend, it is a matter of great consequence how far this "fault" or "throw," as it is called, extends. It may range from a few feet to many fathoms, and in collieries and ironstone mines an occurrence of this kind sometimes stops the whole work. Supposing our bed is entirely cut off in this way, what is to be done? Fortunately we are provided in a simple way with a rule which in nineteen cases out twenty will enable us to find what we have lost. If the dislocating plane is towards you it shows that the bed on which you are at work, and those with which it is associated, have slipped downwards, and you will have to look for the dislocated portion higher up on the other side. The reason is easy to understand. A series of cracks have been formed in the crust of the earth, and the action of gravitation causes one or other to slip down, as it were, on an inclined plane. There are some who cavil at this explanation, but those who examine the thing underground will soon satisfy themselves that it is the true one. If we take the angle of inclination and find it dipping towards us as we approach it, we shall have to seek for the continuation of the bed in the upper ground. It would, of course, be just the reverse if the angle of inclination dips away from us, and we must then seek in the lower ground for our object. Dislocations of this kind, however, necessitate great alterations in the modes of working, and sometimes, as I have said, lead to a total stoppage of the works. Thus although, as a general rule, we may find out the direction of a fault the amount of it may be quite a mystery, and can only be approximately guessed by a knowledge of the district. In some districts faults are of small account, while in others miners are accustomed to deal with them of an extent ranging from 100 to 300 feet. Cases, unfortunately not very frequent, occur in which, the beds having been forced up, the higher portion has also been moved horizontally, so that the dislocated ends overlap, and thus, instead of the fault producing dead ground, it doubles, as it were, the productive beds at that point. This is seen in a remarkable degree at Radstock, in Somerset, where they have the seams twice over just in this way. On the other hand, where the seams are dislocated at a considerable angle, there are very large spaces without any coal at all. The breadth of a fault or of the faults in a district are matters of great importance in purchasing the right to work coal within a certain area. If the liability of the seams to these interruptions is not taken into account, heavy losses may be the result. These faults are seldom shown at the surface, for although one portion of a dislocated series of beds may have slipped down a distance as great as 300 ft., the surface difference in the lapse of ages has been smoothed away, and left no exterior sign. They may, however, sometimes be traced by springs of water oozing from the cracks, and making their way along the fault, which, for the same reason, is occasionally marked by a line of rushes. Although it is an easy matter in some cases to see what the strata look like at their backs or outcrop, there are others in which the most practised observer may find himself beset with difficulties. Thus, in slatey rocks, when slate quarries are opened on a large scale—and there are no countries in the world equal in that respect to Great Britain—a very distinct cleavage is often perceptible, and the laminæ well defined. Nothing is more natural than to believe that these laminæ are beds; but it almost invariably happens that they are not parallel to the strata of the district. Indeed, the planes of cleavage frequently follow a direction exactly contrary, or nearly so, to the regular bedding of the district. Want of attention to this fact has frequently led to great disappointments and the expenditure of many thousands of pounds to no profitable purpose.

We now pass into a class of deposits in which there is a total absence of parallelism to the rocks, and which, as a general rule, cut athwart the parallel beds, though there are abundant cases in which they lie between them. These are mineral veins or lodes. In order to get a fair understanding of what these are, it is necessary to discard altogether the fanciful idea that they resemble the branches of trees or the veins of an animal body. Nothing could be more contrary to the true character of mineral veins and lodes. Supposing a chasm was opened along the Strand, of which you could not see the bottom, extending sometimes from side to side, and at others carrying the edges so near as to leave a space between of only 1 or 2 in., and sometimes of 6, 8, or 10 in.; and supposing it to go up to St. Pauls, and thence in an easterly direction to the Bank, that would give you a fair notion of the space and form of mineral veins. Imagine, then, this chasm to be filled in with a variety of substances, some hard, some soft; in one place spars and other like substances; in others certain minerals of different kinds, metallic or non-metallic, and you will have a good notion of the nature of veins. They have, you will perceive, their two sides more or less parallel; but, nevertheless, they cut through all the other masses of rock in which they are enclosed, and must, therefore, be regarded as having their origin at a more recent date. It is, in fact, impossible to consider them as formed, except subsequently to the consolidation of the rocks. We will now look at the subject of mineral veins from various points, such as the appearances they put on if examined at particular points, the length and depth to which they may be expected to go, their character as affected by other veins running parallel or across them, or by the surrounding "country." These fissures, with rough jagged sides in some places, and at others smooth and regular, are found in many cases to be filled in so that the earlier deposits have left hollow spaces, which are occupied by softer material, as sands or clays, obviously introduced by water. In other cases chemical action has manifestly been strongly at work, and produced crystalline appearances, often of great beauty and interest. The minerals found in veins are usually crystalline, and sometimes they are beautifully crystallised. When the lodes are thus cavernous the miners call them "vughy." I have used the terms "lode" and "vein" indiscriminately, but the former is the word usually employed in the western districts, and the latter in the Centre and North of England. In French and Spanish the term for veins is "filons;" in German "gang," as applied to the principal vein of a district, which is called "hauptgang." It is important to know these continental terms, as they do not appear in the ordinary dictionaries. There are one or two scientific books, in which the word "gang" has been translated as if it were "gangue," and the result is in many instances an unintelligible hash. The smaller veins receive other names, as, for instance, in the western districts they are called "branches;" but it must not by any means be supposed that there is, therefore, any likeness in them to the branches of a tree at the source of which a trunk of ore will be found. The application of the word is somewhat arbitrary, as for instance, in coming to a part of a vein exceedingly rich in tin ore it would be called "a good branch of tin." In other cases they are called "strings," and, if very small, "threads." The first thing to be noticed in respect to lodes is that they not only have no parallelism to the beds of the country, but the material within them, whether metallic or non-metallic, is most capriciously distributed. Accurate observation, therefore, of the depositaries or beds in which lodes are placed is necessary in the first instance, and then of their nature and composition. We must ascertain the "bearing," or "dip," or "hade," or "underlie," as it is variously termed; but which simply means the angle at which they are inclined; and whereas in ordinary cases the beds or strata are more or less horizontal these lodes are more or less vertical. There are, of course, exceptions, and I have already mentioned cases in which the lodes are nearly flat. Sometimes a lode will dip at a certain angle of inclination for a time, and then become more perpendicular. In some districts they are tolerably uniform, and in others they vary very much. Thus, in Cornwall, they are not found in any given district to change materially, but in the North of England they not unfrequently shift from a direction nearly vertical to one almost flat, and then after a time become nearly perpendicular again, and so on. These are matters which must always be gone into, because in laying out the works of a mine the future must be looked to. Sometimes a vein will be vertical to a great depth, and may be worked for many fathoms by a perpendicular shaft on the vein. If the vein be found to have a high angle it is called "a right lode," and if the reverse (at an angle, say, of 30°) a "flat lode." These flat lodes in Saxony are called "schewende," but we have some remarkable examples in this country. Thus, in the Wheal Jane, near St. Agnes, Cornwall, the lode descends at so gradual a slope that a person may actually walk down on its under side. With regard to the hade or dip, as a general rule, this angle is taken from a horizontal line at the surface, but in the West of England the underlie is taken from the perpendicular. A cross-line from the perpendicular represents the amount of the dip. Thus, if at the depth of a fathom it is found to be 1 ft. or 2 ft. from the perpendicular the underlie is said to be at the rate of 1 ft. or 2 ft., as the case may be, in the fathom. With reference to the thickness of veins, you will have gathered that they are extremely variable, and of all the uncertain things in the world these veins are the most uncertain; but whether a vein will pay to work depends less on its size than on the nature of the minerals within it. There are mines which are exceedingly profitable, although the lodes are only strings, but then the metals obtained are gold and tellurium. This is remarkably the case in the mines of Transylvania and Eastern Hungary, where at a place called Zalathna gold is obtained from a vein no thicker than the blade of a knife; and at Nagybanya, in the same district, where tellurium is obtained with the gold, the veins are only a little thicker. When veins of this small size contain only iron or lead it is not worth while to follow them up, but it sometimes happens that a number of these strings coming near together contain in the lead sufficient silver to make their working profitable. As a general rule, however, the metallic veins which are workable range in size from 2 feet to 6 feet, 8 feet, or 10 feet in breadth between the walls, or "cheeks," as they are called in the North of England. The upper boundary is called "the hanging wall," and the lower the "footwall," or "sole." When the veins run about north and south the eastern wall is called the "sun cheek," or the "sun side of the vein." No rule can be laid down as to the percentage of metal in any given thickness of vein-stone which will make it worth working, but, as a fact, the contents will generally be found to be extremely mixed. Taking the generality of veins in this country, 10 ft. to 15 ft. is considered large; but there are plenty of examples of much greater thickness. As, for instance, in the celebrated mine of the Devon Great Consols the vein was 40 ft. from wall to wall, and some portions of that vein exhibited hardly anything but a mass of rich copper ore from side to side. The principal vein in the Foxdale Mine, in the Isle of Man, is 36 ft. in width, containing argentiferous lead ore, disseminated quite through it in many places, although in other parts it is entirely dead. The West Sharp Tor, in Eastern Cornwall, has lodes 40 ft. or 50 ft. in width; but these dimensions are exceeded greatly by certain veins, which, taking into account certain ribs of true but dead veinstone, reach no less than 100 ft. or 120 ft. in thickness. Amongst these are the great silver mines of Schemnitz, in Hungary, and the Veta Madre of Guanaxuato, in Mexico.

LECTURE IV.—Having looked at the structure and nature—the natural history it might be termed—of mineral veins or lodes, it must have been evident to you that a thorough acquaintance with these series of phenomena is a condition of success in the exploration of new districts and in the working of mines. It is on the appearance of these veins, and the judgment formed on them as to whether they are likely to turn out well or otherwise that the employment of capital is based. I have mentioned some cases in which the veins are remarkably small, and others in which they are just the reverse, and given you a few of the dimensions of the larger ones; but it would be very unsound and unsatisfactory if I did not, at the same time, warn you that these large lodes frequently change very rapidly, both as to their dimensions and the value of their contents. Thus there are examples in which lodes of enormous size have become suddenly so small as to be unrecognisable as veins, and instead of having a thickness of from 10 to 40 ft., are reduced to mere strings, or threads, or joints passing through the surrounding strata. Amongst the most notable cases of extreme size, I have mentioned that many of these great veins include within them considerable portions of "country," or rock through which the vein passes. You would, therefore, make a fallacious estimate of the amount of ore likely to be raised from a lode of a given size if you did not take such facts into consideration. I do not know a finer example of this than is presented by the magnificent lode of Bradden Head, the whole of which is visible 100 ft. high on a perpendicular cliff (and which afterwards passes to a considerable depth below the sea level), presenting a most picturesque appearance. But we should go wrong if, taking its measurement at from 60 to 80 ft. in breadth, we should reckon the whole vein as composed of metalliferous deposits. There are, on the contrary, manifest divisions into three distinct bands, which the miners locally call the "east," "middle," and "west" lodes; and besides these, there is a fourth, called the "bulwark," because it passes under the sea, and appears to protect the remainder from the invasion of the water. The orey part, however, is not above 6 ft. in width, but for all that the whole must be reckoned as the lode. In fact, this great mass is a system of fissures which are filled with different material at probably different periods. Just in the same way, the large lodes of Mexico and Hungary, which are of immense magnitude, a considerable portion of the country rock is included in the extreme limits of the lode. There are also instances of mineral repositaries about which doubts exist as to whether or not they belong to the category of lodes properly so called. The Belston lode, in the Thursdon Mine, near Dublin, is an instance of this kind, yielding a vast amount of copper ores, which with all other substances in the vein, presenting such a parallelism as to make it difficult to say whether they are true beds or true veins. In the mine designated the Belston Consols what is called the main lode, which dips at a considerable angle to the north, is at 30 fms. from the surface about 100 ft. in breadth. This mass contains between the hanging and foot wall gault, serpentine, and various other non-metallic materials, but with an admixture of oxides and carbonates of copper, yielding for the market a vast quantity of copper ore, which is saleable at a very high price. On the hanging side the contents of the lode lie in very distinct layers. First solid garnet, with specks of copper ore, then come other layers of different material, and the whole so presented that one cannot help regarding it as a mixture of really stratified deposits with the peculiar action which has produced lodes. Indeed, it is hard to say whether it ought to be regarded as a seam or as an enormous vein. It is an exceptional case, but I have cited it in order to show that you should be on your guard against treating formations of this kind either as beds or lodes without proper investigation. Lodes are sometimes defined with great distinctness, and in the cases in the Museum, up stairs, there is a fine collection of examples, in which the boundaries of the lode are most distinctly shown. In some instances vein-walls are polished like glass, and that for 100 fathoms at a time, showing that considerable mechanical movement has taken place since the filling in of the lode. In opening out a lode, however, a polished surface of this kind must not always be taken as the real wall of the lode. If a vein breaks away easily from the country rock the miners are apt to neglect the real boundary, and especially if they are paid according to the length of ground they cut out. They may, in such cases, be leaving a valuable portion of the lode behind them. I can tell you of a mine in Cardiganshire, which for the last 25 years has paid great profits, where the working had been conducted along a vein which it was supposed was entirely removed, but at length cutting through what appeared to be the wall, some suspicion having arisen, it was found that the best and richest part of the lode had been left on the other side of the plane, which had been taken for the true wall.

Supposing, then, we have satisfied ourselves as to the real width of a lode, we shall often find it bounded on each side by a thin coat of clay, called "stickings" (German "besteg"), and this may make all the difference whether a lode will pay or not. The lode may by its means break away with great facility from the rock, which may be one of great hardness, and to which, if the "stickings" were not there, it would adhere with tenacity, and the cost of breaking it away absorb all the profits. In other instances instead of this clay the lode adjoins beds of softer or of broken material, and on one side (or, perhaps, on both) it is difficult to find walls at all, and the lode is only to be discerned by small strings. This is the case oftener with the hanging than with the footwall, and when it happens the drivings or workings may be carried on for a length of time in a state of doubt as to whether they are in or not in the lode. Events of this kind cause great uneasiness, and it is frequently necessary to go back to where the lode was last, undoubtedly, seen, and try if it has not passed off in another direction. These difficulties sometimes spring up even in well-defined and rich lodes, when the metallic deposits suddenly grow poor, and for a time almost disappear. Sometimes against the walls, instead of a division or parting of clay, the miner gets a mixture of hard material, grey, or almost black in colour, composed principally of quartzose substances as hard as any granite, and called "capel." Formerly these capels were passed by without much observation, but in the present day they have been looked into more closely, and it has been found that a large proportion of them have diffused through them minute particles of valuable tinstone. Capels have been rejected by hundreds of tons, or left at the bottom of mines as valueless, and yet they contain a sufficient proportion of tin ore to pay for its extraction. The term is also applied to ribs of uncrystallised quartz, which sometimes occur, and are utterly valueless. The lecturer then exhibited a number of specimens of capels brought from the neighbourhood of Liskeard. In the Phœnix Copper Mine, on the north of that town, the capel, which is many feet in thickness, was found to assume a peculiar crystalline aspect, exhibiting so much tin that it has been found advisable to go to a large outlay for apparatus and the necessary processes for dressing that ore. When these hard materials stick against the sides they are called "scrows" in Cornwall, and they sometimes have to be worked out before the other portions of the vein can be got. Again, the veins sometimes extend beyond the walls into the adjoining country. This generally occurs in the shape of strings, or little specks of metal, and sometimes to such an extent as to make it worth while to work outside the wall. And in searching for riches, appearances of this sort indicate that the vein is at hand. This peculiarity is frequently observed in the neighbourhood of both gold and silver veins, and in the latter beautiful delicate scales of native silver will be found in the rock adjacent to the vein. Instances of this kind are not infrequent in Saxony and Transylvania in connection with ores and tellurium.

Let us now look a little at the interior of the vein, and what we should expect it to be filled with. It is on this point more than any other that we shall have uncertainty and variableness. Thus, it is not sufficient to explore a lode at any single point to form a correct judgment as to its value, or what it is likely to yield beyond that point. A lode which may have been very rich up to a certain point, sometimes becomes utterly poor, as happened to the Great Devon Consols lode towards its termination. The first accident to the vein occurred when it was from 20 feet to 30 feet wide. A great dislocating plane or cross-course came in and heaved or threw it out many fathoms. This did not injure it, for it was found to be just as rich beyond the throw as before, and at no great distance beyond that it opened out to 40 ft. or 50 ft.; but at a few fathoms farther the copper ore completely disappeared. Metalliferous mining is, therefore, a continual system of exploration of the country; and a continual system of new openings on a lode, to ascertain and determine what part is most worth working.

PUDDLING IRON.—An invention, communicated to Mr. H. E. NEWTON, of Chancery-lane, consists in reducing the cast-iron to coarse granules or pieces, so that they may melt down more quickly than pigs into a fluid state. Granules or pieces, varying in bulk from spheres of about 2-10ths of an inch to 1 in. in diameter, with a small portion larger and smaller than these limits, have been found in practice to work satisfactorily. Care must be taken, however, not to make too large a proportion of fine granules, as in that case they would quickly be decarbonised and rendered infusible, and thus prevented from melting and mixing in a liquid condition with the liquid iron oxide. Such a mixture of the iron (in a liquid state) with the liquid oxide is indispensable to the complete success of the process.

THE SALT BED AT MIDDLESBOROUGH.

A paper "On the New Red Sandstone of Cleveland, and the Rock Salt discovered in it," was read, on Monday, by Mr. W. H. PEACOCK (author of "A Popular Treatise on Coal Mining"), mining engineer, before the Science Section of the Cleveland Literary and Philosophical Society, at their rooms, Railway Crossing, Middlesborough. The chair was occupied by Mr. JOHN JONES, F.G.S., and there was a large attendance. We give below a short abstract of the paper:—

Although, since the discovery of this immense bed of salt, six years ago, the subject has to a certain extent slumbered, public opinion has in the interval been gradually ripening to a conviction that this district must in the future, from its geographical position, command a considerable share of the trade in salt, at present monopolised by the county of Cheshire. The discovery of beds of salt in the New Red Sandstone of Cleveland, although taking most persons by surprise at the time, had been foretold by Greenwell, in the first edition of his work on mining engineering, published in 1853, and the Rev. George Young, in his "Geology of the Yorkshire Coast," published in 1828, hints at the same result. The New Red Sandstone or trias, where fully developed, as on the Continent, consists of three groups—the keuper, muschelkalk, and bunter. In England, the middle formation is entirely wanting. The most recent classification, as now adopted by the Geological Survey, is as follows:—

A 1. Rhoetic or Penarth beds.
A 2. New red marl.
A 3. Lower keuper sandstone.
B. Wanting in England (Muschelkalk).
C 1. Upper mottled sandstone.
C 2. Pebble beds.
C 3. Lower mottled sandstone.

The Middlesborough section, of 1306 ft., is considered to be entirely in A 2, leaving A 3 and C 1, 2, and 3 yet unproved. In Cheshire, the New Red Sandstone is estimated by Mr. Ormerod to be 1700 ft. thick, as follows:—

A 2. (including salt and gypsum) .... Feet	700
A 3. Lower keuper and water stones	400
C 1, 2, and 3, or bunter sandstone	600=1700

A 2, or 700 ft., being considered as corresponding with the 1306 ft. at Middlesborough, according to this estimate, we shall have at least 1000 ft. to go before reaching the magnesian limestone, making a total of 2306 ft. of New Red Sandstone, but as an extra development of the upper keuper formation has been proved at Middlesborough, a similar increased development of the lower keuper and bunter may be looked for, hence it is not improbable that the New Red Sandstone may attain a considerably greater thickness than 2306 feet. Previous to Messrs. Bolckow and Vaughan's bore-hole very little was known as to the thickness of the New Red Sandstone in Cleveland, no boring previously having reached a greater depth than 700 ft. In Cheshire and some of the Midland Counties the New Red Sandstone occupies the same advantageous position for examination as the lias in the Cleveland hills, presenting fine exposed sections; but in Cleveland, owing to the depth of alluvium which covers the vale of the Tees, our knowledge of the New Red Sandstone has been, and must continue to be, almost entirely confined to an examination of borings and sinkings. A very interesting boring was made at Coatham, near Redcar, about two years ago, through the lower lias shale, and into the new red marl, attaining a depth of 56 fms., being put down in hopes of finding salt nearer the surface than proved at Middlesborough upon the strength of the known existence of a very strong feeder of brine, proved several years before in a pit put down in search for coal. This Coatham boring was the first in Cleveland which proved the bottom of the lower lias shale and its junction with the New Red Sandstone portions of the rhoetic formation, it is considered, are displayed, formerly regarded as the bottom of the lower lias, but now as the upper capping of the New Red Sandstone. The outcrop of the New Red Sandstone on the Durham side of the river may be taken as a curved line from Simpasture to Sedgefield on to South Wingate Colliery, and thence to the sea coast. The average inclination of the lias in the Eston hills may be taken at 2¼ in. to the yard, or 1 in 16 north-west. Assuming that the lias and New Red Sandstone are conformable, and commencing at the outcrop alluded to, a dip of 1 in 16 at right angles to the line of outcrop, and eight miles north-west of Middlesborough, will give at the latter place a total depth of 2640 ft. as the thickness of the New Red Sandstone, and the theoretical thickness we have shown to be 2306 ft.—comparatively a small discrepancy between the two theories. The new red marl or upper keuper would, according to this hypothesis, crop out about Greatham, the lower keuper or water stones a little beyond Oughton, and the bunter sandstone at the general outcrop line of the New Red Sandstone. This theory may or may not be correct—actual operations will probably determine, but the weight of all the evidence obtainable is against the idea of the New Red Sandstone being at a dead level over any considerable distance. It is highly improbable that the Middlesborough salt bed will extend as far as the supposed outcrop of the upper keuper near Greatham. Taking Cheshire as a guide, we find that the main beds of rock salt in that county extend into an irregular oval area about 1½ mile long by ¾ of a mile broad. There will be 3000 feet of New Red Sandstone and magnesian limestone at Middlesborough—a depth so great as almost to forbid the hope of further explorations beneath the magnesian being practicable. Various opinions are entertained as to the probability of coal being found beneath these formations in Cleveland, but from Sir Roderick Murchison and Mr. Hull downwards most of the geological authorities are now of opinion that both the Durham and Yorkshire coal fields are each true self-contained basins. An interesting boring was made at Kirk Leavington, near Yarm, in the year 1857, in search for coal. This stopped at a depth of 120 fathoms, and is reported to have entered the magnesian limestone, but it is more probable that the limestone rock penetrated was one of the dolomitic conglomerates or crystalline limestones peculiar to the base of the keuper formation. The New Red Sandstone will probably be found to be thinning out both to the north and west of Middlesborough, but the base of the bunter can hardly be at Kirkleavington. The three chief commercial products of the New Red are salt, gypsum, and water. First, as regards salt, 1,500,000 tons, are annually produced in Great Britain and Ireland, and of this at least one-third, or 500,000 tons, will probably eventually be supplied from Middlesborough. The carriage of salt to the Tyne from Cheshire, either across the country by rail or by canal to Hull and Grimsby, is in either case about 7s. per ton; and as salt can be shipped at Middlesborough to the Tyne for 2s. per ton, it is evident that as regards the Tyne consumption (now about 150,000 tons annually) Middlesborough possesses in the mere item of carriage alone an advantage of 5s. per ton over Cheshire; the whole of the export trade to Northern Europe, now about 150,000 tons, must also be supplied from the Tees; for a similar reason a portion of the home consumption will also be secured by the Tees, besides a share of the export trade to other countries, such as India, Africa, &c. The export trade is a steadily increasing one; during the last four years it has been increasing at the average rate of 70,000 tons per annum, a hopeful fact for the future Middlesborough salt trade. As regards the second commercial product of the New Red Sandstone, gypsum, it is a mineral of such insignificance commercially that little need be said. The third product is water. Messrs. Bolckow and Vaughan originally put down their bore-hole in search for water, but as they never reached the bunter sandstone, which alone yields water in any quantity, their expectations were disappointed. The bunter is the finest water-bearing strata in England, thirteen large towns in the west of England being supplied from wells in the bunter sandstone; Liverpool, Manchester, and neighbourhood pumping daily nearly 20,000,000 gallons from the bunter; and it is the purest drinking water known, occupying a middle position between the hard water of the chalk and the river water from surface drainage. From the great depth at which the bunter will probably be found at Middlesborough, enormous stores of pure water may be expected on reaching this formation. The bed of salt above will not damage the quality, because between the bunter and the red marl exist a series of laminated sandstones, called water stones, and impervious to water. The large works at Middlesborough could thus, by each putting down and tubing a bore-hole, obtain the purest water, and so save many thousands a year in water rates. Many other interesting subjects were touched upon in Mr. Peacock's paper, which was embellished by detailed sections of all the bore-holes put down in the New Red Sandstone, and will form, when printed in detail, a most valuable assistance in deciphering the New Red Sandstone of Cleveland. The Literary and Philosophical Society may be congratulated on receiving so valuable an accession to their Transactions.

At the conclusion of Mr. Peacock's paper a unanimous vote of thanks was passed, and on the motion of Mr. John Jones, F.G.S., the President of the Science Section, it was agreed that, in consideration of the great importance of the subject, the paper be at once printed and circulated amongst the members. The following gentlemen then took part in the discussion which followed the reading of the paper:—

Mr. JENNINGS was afraid the trade in salt was likely to be injured by the discovery of salt beds on the Continent. As regards the Middlesborough boring, he was sure Messrs. Bolckow and Vaughan acted upon good advice in the conduct of that undertaking. He would not like to invest money in such a water scheme as named.

The TOWN CLERK (Mr. J. T. Belk) considered the question of water, as propounded by Mr. Peacock, was of the greatest importance, and would suggest to the Science Section that a committee be appointed to consider and report specially upon this part of the paper. Mr. Peacock would, perhaps, state the probable cost of such an undertaking.

Mr. CHARLTON desired to have a further expression of opinion as to the probable extent of the salt around Middlesborough.

Mr. JONES, F.G.S., agreed in the main with all the views expressed in the paper, and thought the water question, as propounded by Mr. Peacock, of the greatest importance, and considered it highly probable that immense quantities of water will be obtained on tapping the bunter sandstone. He was pleased to find that the rhoetic or penarth beds had been recognised in the Coatham boring, as this formation was one of great geological interest.

Other gentlemen having spoken,

Mr. PEACOCK, in commenting upon the remarks made, said, in answer to Mr. Jennings, it was true salt deposits had been discovered on the Continent, but any damage on this score would be probably more than compensated for by extra local consumption. The great agricultural district of Cleveland would use much larger quantities of salt for manure than hitherto. As regards the water scheme, there were exceptional reasons which caused so great an outlay in the boring by Messrs. Bolckow and Vaughan. The science of deep boring was then more in its infancy than now. As they never reached the true water-bearing part of the New Red Sandstone system, no reflection could be made upon them. It was probably the hope of the London engineer who advised them in the matter that they would in time reach the bunter sandstone.

In answer to the Town Clerk, Mr. PEACOCK said the cost of deep boring to the bunter, inclusive of tubing the hole, would probably be under 10,000*l.* considerably.—In reply to Mr. Charlton, he added that Cheshire may be taken as a guide as to the extent of our salt deposit at Middlesborough, and in that county, as stated in the paper, the rock salt extends 1½ mile by three-quarters of a mile. If we have salt within a radius of a mile of Middlesborough, then we have enough salt for generations; and it is to be hoped, from a Middlesborough point of view, that so valuable a deposit does not extend to Stockton.

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